The Integration of Marine Renewable Energies in Multi-Use Offshore Platforms in the scope of the FP7 TROPOS Project

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Abstract

The FP7 funded TROPOS project has integrated in a multipurpose platform offshore transport services, energy, aquaculture and leisure. The project considers marine renewable energies a key aspect of the whole concept of a Multi-Use Offshore Platform, which has been applied to the Mediterranean, tropical and sub-tropical regions.

Keywords: multi-purpose, multi-use, offshore, platform, marine renewable energy.

1. Introduction

Sites to install marine renewables in coastal areas are limited. Therefore, there is an increasing interest in offshore areas. An integrated approach is needed to prevent conflicts between novel maritime activities in offshore areas, like the development of mariculture and renewable energy sources. The development of Multi-Use Oceanic Platform concepts has clearly become one of the European Union (EU) most interesting and ambitious initiatives to ensure integrated and sustainable use of the marine environment in fields like renewable energies and living resources [1].

The EU launched "The Ocean of Tomorrow" call for Multi-Use Offshore Platforms (MUOP) proposals in 2011. Thereby, the EU has provided the scientific and entrepreneurial community with a total funding of €14 M to finance three projects aiming at designing Offshore Multi-use Platforms. The selected projects – TROPOS [2], H2OCEAN [3] and MERMAID [4] – have been able to integrate the exploitation of various oceanic resources, in particular marine renewables, aquaculture and maritime transport services.

The FP7 TROPOS project aims at developing a deep-water modular multi-use platform. TROPOS project integrates a range of different activities, from transport to energy, aquaculture and leisure. This integration helps to overcome challenges in each of these areas, boosting primarily, among other benefits, the shared use of common infrastructures.

The final objective of the TROPOS project is to design three complete solutions for Multi-use Offshore Platforms (MUOP), one for each of the selected case-scenarios, namely Mediterranean, subtropical and tropical sites. A GIS (Geographical Information System) tool has been used to help the process of selecting the most suitable location for these platforms. The decision process took into account a detailed resource assessment. In the case of renewable energies this assessment included detailed studies on wave energy, wind energy, solar energy, ocean tidal currents and OTEC (Ocean Thermal Energy) in the three regions of interest: Crete Island in Greece (Mediterranean region), Taiwan (tropical region) and Canary Islands (subtropical region). Additionally, as an added value, a site in the North Sea (Dogger Bank area) has also been considered.

TROPOS is also contributing to the Maritime Spatial Planning by developing environmental aspects (Environmental Impact Assessment, Lifecycle Assessment) and integrated planning that are key features to integrate a broad range of functions from several sectors.

2. The TROPOS Project approach

The multi-disciplinary nature of TROPOS represents a significant challenge in terms of standardizing approaches and methodologies. The so-called TEAL (Transport, Energy, Aquaculture and Leisure) sectors have been integrated into different conceptual modules. To identify synergies within this diversity, the project developed a decision methodology based on GIS and on an analysis of the main constraints and compatibilities among platform components. The purpose was to perform a quantitative evaluation of the

specifications of each of the TEAL components, which are related to environmental and socioeconomic aspects, as shown in Figure 1.

Figure 1: The TROPOS TEAL components

The design of the platforms is based also on an iterative process which considers simultaneously numerous interrelated factors which results in a dynamic process. The stages of the process can be defined as follows:

- Identification of requirements and needs to design the platform.
- Selection of the structure type and the conceptual design.
- Detailed design.
- Assessment and fulfilment of technical, economic and environmental requirements.

From the economical point of view a deployment strategy for multiuse offshore platforms has covered the following aspects:

- Project aims, factors included and excluded and components to be incorporated in the platform.
- A scenario for the deployment of a multi-use platform outlining final deployment targets.

From the start of conceptual design, environmental (EIA) and socio-economic aspects (SIA) were studied and fully integrated to ensure the project sustainability. The first step was a thoroughly scoping of possible positive and negative impacts of the project including synergies and cumulative impacts. A literature review (of single- or dual-issue EIAs) was also undertaken, focusing on potential significant impacts, mitigation and monitoring options useful for TROPOS. Finally, a comparison of single-use platforms versus MUOP will be achieved and guidelines prepared, thereby investors will know which environmental aspects to address for their MUOP.

The final design of the TROPOS platforms considers a central unit platform and several modules which can be directly attached to the central unit or connected indirectly (normally via underwater cables).

3. The TROPOS Platform configurations

Renewable energies are in TROPOS the main driver of the different platforms configurations [5]. This section focuses on the interrelationship of the renewable energies with the different platform configurations. These configurations are: *Green & Blue*, *Sustainable Service Hub*, and *Leisure Island*.

Green & Blue

The *Green & Blue* platform follows the strategies and actions defined by the European Commission in the development of aquaculture and renewable energies in the EU. Figure 2 shows an artist impression of this concept.

Figure 2: Green & Blue platform – artist impression [7]

The current concept includes the following objectives and capabilities:

- Energy capacity of 211 MW, 30 floating offshore satellites, each comprised of 2 wind turbines (3.3 MW each) and 434 kW photovoltaic panels, and an aquaculture cage.
- Algae and aquaculture modules: annual production of 7,000 t of fishes (biannual production cycle) and 2,000 t of algae (continues production).
- The fish biomass transformation is performed on board with the following ratios: 25% fresh fish, 55% transformed (Individually Quick Freezing / Modified Atmosphere Product), 20% by-products.
- The algae biomass is dried on site and cold stored.
- The electricity generated by the wind turbines supplies the electrical power consumption of the facility. An electrical energy generator will be developed to supply the platform in emergency situations.

The platform is fitted with accommodation infrastructure for the personnel. In case of external visitors, the infrastructure follows strict security measures. Personnel on-board the platform would be trained to carry out multiple roles to satisfy all the platform needs including health, safety and security requirements, and maintenance roles. The platform is composed of internal modules, central unit platform, and satellite units, these last ones located offshore the platform. These modules and satellite units include:

- Internal Modules
  - Fish Processing Plant.
  - Aquaculture workshop.
  - Aquaculture Support Unit.
  - Algae Biorefinery.
  - Substation.
  - Accommodation.
- Satellite Units for Crete
  - 30x Triangular platform design.
  - Combination of wind turbines, photovoltaic panels and aquaculture units.

Sustainable Service Hub

The *Sustainable Service Hub* platform consists of a deep offshore structure which focuses on transport and energy needs of offshore renewable energy facilities. Figure 3 shows an artist impression of this concept.

Figure 3: Sustainable Service Hub platform – artist impression [7]

The current concept includes the following objectives and capabilities:

- It serves as an Offshore Wind Service Hub to provide maintenance and operation procedures to a wind farm assembled around the platform.
- The platform is equipped with a docking area for vessels, and it will be located and built providing enough clearance for safe access for the vessels to access both the platform and the turbines.
- The electricity generated by the wind turbines directly supplies the electricity consumption of the facility.

The platform is fitted with accommodation infrastructure for the platform workers. It is calculated that there will be approximately 45 full-time personnel on-board the platform. The accommodation module will have the capacity to host 55 personnel (45 full-time with additional room for platform visitors such as inspectors, company executives, R&D researchers, etc.). The platform is composed by four internal modules within the multi-use platform which satisfies the needs of the transport and energy concepts within the TROPOS project. The four modules include:

- Maintenance Base.
- Substation.
- Helipad.
- Accommodation.

Leisure Island

The *Leisure* Island platform combines the touristic sector with the other TROPOS Project components: Transport, Energy and Aquaculture. Figure 4 shows an artist impression of this concept.

Figure 4: Leisure Island platform – artist impression [7]

The current concept includes the following objectives and capabilities:

- It serves as an educational tourism center and hotel to offer tourists an alternative holiday destination. The platform is located in a sustainable and ecological location.
- The platform has a modular structure with the infrastructure capabilities to serve offshore activities for education and leisure purposes.
- On-board visitor capacity: 400, a daily average of 1,040 visitors, 379.552 visitors per year.
- Daily operating time: 10:00 h. to 24:00 h., except for the accommodation module which operates 24 hours a day, and the underwater bar which closes at 18:00 to reduce subsea light disturbance of marine animals.
- Transport from shore to the platform will be provided for visitors via rapid crafts, which have a capacity of 140-150 persons per craft.

- The electricity consumed by the platform will mostly be provided by an onshore position (grid connection). An electricity generator will be developed to supply the platform in emergency situations.

The platform is composed by 7 modules to address the needs of the leisure concept within the TROPOS project. The 7 modules include:

- Marine Science & Attraction Centre (Visitors Centre).
- Food & Beverage.
- Accommodation (Hotel).
- Marina & Nautical Activities Centre.
- Environmental Monitoring & Platform Security.
- Photovoltaic Plant.
- Substation.

The TROPOS Consortium

This ambitious project, with a total budget of €6.7 M including €4.9 M EC funding, requires effective collaboration of a multidisciplinary and highly specialized team in areas such as offshore structures, energy, aquaculture, tourism, maritime transport, socio-economics and environment. Its strong innovative character and the project's key conditions have raised the interest of 20 partners, including European, non-European public research institutions, large companies and small and medium-sized enterprises that excel in the research and expertise in these sectors. The TROPOS Project partners are presented in Table 1 [6].

Nº	Partners	Country
1	Oceanic Platform of the Canary Islands	Spain
2	University of Edinburgh	UK
3	University of Bremen-MARUM	Germany
4	Wave Energy Centre	Portugal
5	Universidad Politécnica de Madrid	Spain
6	Fraunhofer Institute-IWES	Germany
7	Toulon Var Technologies	France
8	Norsk Institutt for Vannforskning	Norway
9	Danmarks Tekniske Universitet	Denmark
10	Abengoa Seapower	Spain
11	Phytolutions GmbH	Germany
12	Hellenic Centre for Marine Research	Greece
13	National Sun Yat Sen University - Taiwan	Taiwan
14	Advance Intelligent Development S.L.	Spain
15	Bureau Veritas	France
16	École Centrale de Nantes	France
17	EnerOcean S.L.	Spain
18	University of Strathclyde	UK
19	Acciona Infrastructures	Spain
20	DCNS	France

Table 1: *TROPOS Project partners*

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